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WILLIAMS POND SUSSEX COUNTY DELAWARE

Pacific Northwest Environmental Research Laboratory

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June 1975

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NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT ON

WILLIAMS POND

SUSSEX COUNTY

DELAWARE

EPA REGION III

WORKING PAPER No. 242

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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WITH THE COOPERATION OF THE

DELAWARE DEPARTMENT OF NATURAL RESOURCES

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DELAWARE NATIONAL GUARD

JUNE 1975

343143

REPORT ON WILLIAMS POND

SUSSEX COUNTY, DELAWARE, EPA REGION III

by

National Eutrophication Survey

Water and Land Monitoring Branch
Monitoring Applications Laboratory
National Environmental Research Center
Las Vegas, Nevada

and

Eutrophication Survey Branch
Pacific Northwest Environmental Research Laboratory
National Environmental Research Center
Corvallis, Oregon

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin

planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Delaware Department of Natural Resources and Environmental Control for professional involvement and to the Delaware National Guard for conducting the tributary sampling phase of the Survey.

Mr. N. C. Vasuki, Director, Division of Water Pollution Control, Department of Natural Resources and Environmental Control, provided invaluable lake documentation and counsel during the course of the Survey.

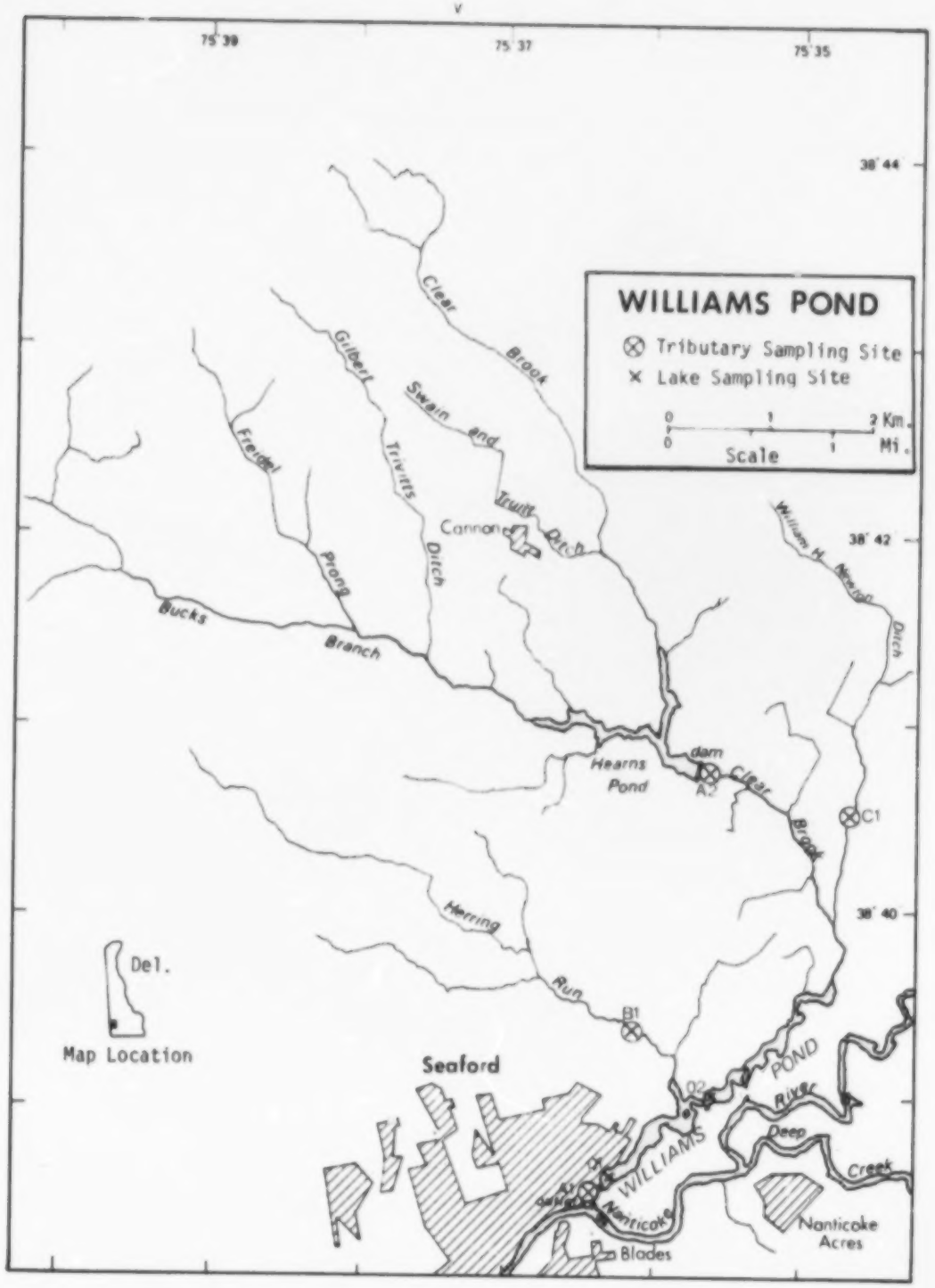
Major General Clarence E. Atkinson, the Adjutant General of Delaware, and Project Officer Colonel Donald S. Robinson, who directed the volunteer efforts of the Delaware National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF DELAWARE

LAKE NAME	COUNTY
Killen Pond	Kent
Moores Lake	Kent
Noxontown Pond	New Castle
Silver Lake	New Castle
Williams Pond	Sussex
Trussum Pond	Sussex


75° 39
75° 37
75° 35
38° 44
38° 42
38° 40
WILLIAMS POND
Tributary Sampling Site
Lake Sampling Site
0 1 2 Km.
0 1 Mi.
Scale
Clear Brook
Gilbert Swain and Truitt Ditch
Freidel Prong
Trivetts Ditch
Cannon
Bucks Branch
Williams Mill Branch Ditch
Hearns Pond dam
A2
C1
Clear Brook
Herring Run
B1
Del.
Map Location
Seaford
B2
POND
Deep Creek
WILLIAMS
Nanticoke
Blades
Nanticoke Acres

WILLIAMS POND

STORET NO. 1009

I. CONCLUSIONS

A. Trophic Condition:

Williams Pond is considered eutrophic based upon field observations and analysis of Survey data. Chlorophyll *a* levels range from a low of 7.4 micrograms/liter in the spring to a high of 61.1 micrograms/liter in the summer. Algal blooms and floating higher aquatic plants were observed during summer and fall sampling. Water clarity was poor, with mean Secchi disc visibility of 128.7 cm. Pollution-tolerant genera were predominant among the phytoplankton identified.

B. Rate-Limiting Nutrient:

Algal assay results indicate that Williams Pond was limited by available phosphorus levels at the time of assay sample collection. The ratios of available nitrogen to orthophosphorus in sampled waters substantiates phosphorus limitation for the spring and fall sampling dates. Nitrogen to phosphorus ratios suggest a tendency to nitrogen limitation for the summer sampling data.

C. Nutrient Controllability:

The phosphorus loading rate for Williams Pond of 6.53 $g/m^2/yr$ exceeds the rate proposed by Vollenweider (in press) as "dangerous" or eutrophic by three times, and the "permissible" or oligotrophic rate by six times. However, Vollenweider's model probably does not apply to water bodies with short hydraulic retention times, and the mean hydraulic retention time of Williams Pond is only 3 days.

There are no known point sources contributing to Williams Pond. Measured tributaries account for 95.7% of the total nonpoint source phosphorus load, and the ungaged drainage areas were estimated to contribute 3.9%.

Of the tributaries sampled, Clear Brook shows a lower nitrogen to phosphorus ratio (8:1) than would be expected from natural runoff. Tributaries with nitrogen to phosphorus ratios less than 14:1 are suspected of being impacted by a point source that was not accounted for in this survey, either from Hearns Pond or the town of Cannon.

Determination of surrounding land uses and unknown sources contributing loading is necessary before recommendations for lake improvement can be proposed.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. The pond surface area was provided by the State of Delaware; mean depth was estimated based on survey data; tributary flow data were provided by the Delaware District Office of the U.S. Geological Survey (USGS)(outlet drainage area includes the lake surface area). Mean hydraulic retention time was obtained by dividing the lake volume by the mean flow of the outlet.

Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 0.34 km^2.
2. Mean depth: 1.2 meters.
3. Maximum depth: 2.1 meters.
4. Volume: 0.408×10^6 m^3.
5. Mean hydraulic retention time: 3 days.

B. Tributary and Outlet (see Appendix C for flow data):

1. Tributaries -

Name	Drainage area(km^2)	Mean flow (m^3/sec)
A(2) Clear Brook	39.6	1.17
B(1) Herring Run	10.4	0.31
C(1) William H. Newton Ditch	5.3	0.01
Minor tributaries & immediate drainage -	4.3	0.04
Totals	59.6	1.53
2. Outlet - A(1) Clear Creek	59.8	1.53

C. Precipitation:

1. Year of sampling: 105.0 centimeters.

2. Mean annual: 109.4 centimeters.

III. LAKE WATER QUALITY SUMMARY

Williams Pond was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the pond and from one or more depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton identification and enumeration. During the first visit, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 1.8 meters at Station 1 and 1.2 meters at Station 2. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III B. Results of the limiting nutrient study are presented in III C.

A. PHYSICAL AND CHEMICAL CHARACTERISTICS:

PARAMETER	N*	(4/10/73) S*** = 2 RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	N*	(7/20/73) S*** = 2 RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	N*	(9/28/73) S*** = 2 RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	3	13.8- 14.2	13.8	0.0- 1.2	3	27.2- 28.6	28.3	0.0- 1.2	3	21.0- 22.2	22.0	0.0- 1.5
MAX DEPTH**	2	13.8- 14.1	13.9	1.2- 1.8	2	27.2- 28.6	27.9	0.0- 1.2	2	21.0- 22.2	21.6	0.0- 1.5
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	1	10.0- 10.0	10.0	1.2- 1.2	2	6.2- 12.1	9.1	0.0- 1.2	2	8.6- 10.0	9.3	0.0- 0.0
MAX DEPTH**	2	10.0- 10.1	10.0	1.2- 1.8	2	6.2- 12.1	9.1	0.0- 1.2	1	8.6- 8.6	8.6	0.0- 0.0
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	3	98.- 102.	98.	0.0- 1.2	3	108.- 112.	111.	0.0- 1.2	3	86.- 88.	87.	0.0- 1.5
MAX DEPTH**	2	98.- 101.	100.	1.2- 1.8	2	108.- 111.	110.	0.0- 1.2	2	87.- 88.	88.	0.0- 1.5
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	3	8.1- 8.5	8.5	0.0- 1.2	3	7.3- 9.5	8.5	0.0- 1.2	2	7.7- 7.7	7.7	0.0- 0.0
MAX DEPTH**	2	8.1- 8.5	8.3	1.2- 1.8	2	7.3- 9.5	8.4	0.0- 1.2	1	7.7- 7.7	7.7	0.0- 0.0
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	3	12.- 15.	12.	0.0- 1.2	3	22.- 25.	24.	0.0- 1.2	2	18.- 19.	19.	0.0- 0.0
MAX DEPTH**	2	12.- 12.	12.	1.2- 1.8	2	22.- 24.	23.	0.0- 1.2	1	19.- 19.	19.	0.0- 0.0
TOTAL P (MG/L)												
0.-1.5 M DEPTH	3	0.037-0.038	0.037	0.0- 1.2	3	0.086-0.100	0.093	0.0- 1.2	2	0.042-0.044	0.043	0.0- 0.0
MAX DEPTH**	2	0.034-0.037	0.035	1.2- 1.8	2	0.093-0.100	0.096	0.0- 1.2	1	0.044-0.044	0.044	0.0- 0.0
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	3	0.008-0.011	0.008	0.0- 1.2	3	0.010-0.012	0.010	0.0- 1.2	2	0.012-0.014	0.013	0.0- 0.0
MAX DEPTH**	2	0.008-0.008	0.008	1.2- 1.8	2	0.010-0.012	0.011	0.0- 1.2	1	0.012-0.012	0.012	0.0- 0.0
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	3	2.200-2.500	2.200	0.0- 1.2	3	0.060-0.100	0.080	0.0- 1.2	2	1.700-1.950	1.825	0.0- 0.0
MAX DEPTH**	2	2.200-2.600	2.400	1.2- 1.8	2	0.060-0.080	0.070	0.0- 1.2	1	1.700-1.700	1.700	0.0- 0.0
AMMONIA (MG/L)												
0.-1.5 M DEPTH	3	0.040-0.060	0.050	0.0- 1.2	3	0.040-0.090	0.050	0.0- 1.2	2	0.040-0.060	0.050	0.0- 0.0
MAX DEPTH**	2	0.040-0.050	0.045	1.2- 1.8	2	0.040-0.090	0.065	0.0- 1.2	1	0.040-0.040	0.040	0.0- 0.0
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	3	0.600-0.700	0.700	0.0- 1.2	3	1.100-1.100	1.100	0.0- 1.2	2	0.800-0.800	0.800	0.0- 0.0
MAX DEPTH**	2	0.600-0.700	0.650	1.2- 1.8	2	1.100-1.100	1.100	0.0- 1.2	1	0.800-0.800	0.800	0.0- 0.0
SECCHI DISC (METERS)												
	2	1.0- 1.1	1.0		2	0.9- 1.1	1.0		2	1.8- 1.8	1.8	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/10/73	1. Flagellates	4,727
	2. Melosira	1,504
	3. Asterionella	1,504
	4. Navicula	129
	5. Dictyosphaerium	129
	Other genera	430
	Total	8,423
07/20/73	1. Flagellates	8,060
	2. Dactylococcopsis	7,233
	3. Chlamydomonas	6,614
	4. Scenedesmus	5,476
	5. Coelastrum	1,550
	Other genera	4,952
	Total	33,885
09/28/73	1. Flagellates	1,484
	2. Oscillatoria	812
	3. Melosira	504
	4. Blue-green filament	476
	5. Microcystis	476
	Other genera	2,268
	Total	6,020

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (micrograms/liter)
04/10/73	1	13.5
	2	7.4
07/20/73	1	61.1
	2	54.9
09/28/73	1	20.9
	2	22.8

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.012	2.24	0.5
0.05 P	0.062	2.24	24.6
0.05 P + 1.0 N	0.062	3.24	28.4
1.00 N	0.012	3.24	0.8

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Williams Pond was moderate at the time the sample was collected. Increasing yields with the addition of phosphorus and the lack of response to the addition of nitrogen indicate that this pond is phosphorus limited. Maximum growth response was achieved with the simultaneous addition of nitrogen and phosphorus.

The ratios of the mean total available inorganic nitrogen to orthophosphorus for the spring and fall samplings were 269:1 and 144:1, respectively, indicating phosphorus limitation at those times. The summer nitrogen to phosphorus ratio was 13:1, suggesting a tendency for the lake to be nitrogen limited at that time.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Delaware National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of March when two samples were collected. Sampling was begun in April 1973 and was completed in March 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Delaware District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of the USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual concentrations in Clear Brook and William H. Newton Ditch at Stations A(2) and C(1) and mean annual ZZ flow.

A. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A(2) Clear Brook	1,760	79.3
B(1) Herring Run	345	15.5
C(1) William H. Newton Ditch	20	0.9
b. Minor tributaries & immediate drainage (nonpoint load) -	85	3.9
c. Known municipal STP's - None		
d. Septic tanks* -	5	0.2
e. Known industrial - None		
f. Direct precipitation** -	5	0.2
Total	2,220	100.0
2. Outputs - A(1) Clear Creek	2,155	
3. Net annual P accumulation -	65	

*Estimate based on 11 lakeshore residences.
**Estimated (see NES Working Paper No. 175).

B. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source		kg N/yr	% of total
a.	Tributaries (nonpoint load) -		
	A(2) Clear Brook	106,855	65.9
	B(1) Herring Run	52,070	32.1
	C(1) William H. Newton Ditch	340	0.2
b.	Minor tributaries & immediate drainage (nonpoint load) -	2,570	1.6
c.	Known municipal STP's - None		
d.	Septic tanks* -	5	< 0.1
e.	Known industrial - None		
f.	Direct precipitation** -	370	0.2
	Total	162,210	100.0

2. Output - A(1) Clear Creek 129,955

3. Net annual N accumulation - 32,255

*Estimate based on 11 lakeshore residences.
**Estimated (see NES Working Paper No. 175).

C. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
A(2) Clear Brook	44	2,698
B(1) Herring Run	33	5,007
C(1) William H. Newton Ditch	4	64

D. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible."

	Total Yearly Phosphorus Loading Rate (grams/m^2/year)
Estimated loading rate for Williams Pond	6.53
Vollenweider's "dangerous" or eutrophic rate	2.24
Vollenweider's "permissible" or oligotrophic rate	1.12

V. LITERATURE REVIEWED

U.S. Environmental Protection Agency. 1975. "National Eutrophication Survey Methods 1973-1976." Working Paper No. 175. NERC, Las Vegas, Nevada, and PNERL, Corvallis, Oregon.

Vollenweider, Richard A. (in press). "Input-Output Models." Schweiz. Z. Hydrol.

VI. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

PARAMETRIC RANKINGS OF LAKES

SAMPLED BY NES IN 1973

STATE OF DELAWARE

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
1002	KILLEN POND	0.170	1.610	479.333	116.200	12.000	0.042
1005	MOORES LAKE	0.245	2.400	472.667	81.267	4.700	0.071
1007	NOXONTOWN POND	0.160	0.530	478.833	37.600	10.400	0.016
1008	SILVER LAKE	0.227	4.750	465.667	26.700	13.000	0.096
1009	WILLIAMS POND	0.042	2.010	449.333	30.100	8.800	0.010
1010	TRUSSUM POND	0.038	1.280	464.000	5.100	5.800	0.011

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
1002	KILLEN POND	40 (2)	60 (3)	0 (0)	0 (0)	20 (1)	40 (2)
1005	MOORES LAKE	0 (0)	20 (1)	40 (2)	20 (1)	100 (5)	20 (1)
1007	NOXONTOWN POND	60 (3)	100 (5)	20 (1)	40 (2)	40 (2)	60 (3)
1008	SILVER LAKE	20 (1)	0 (0)	60 (3)	80 (4)	0 (0)	0 (0)
1009	WILLIAMS POND	80 (4)	40 (2)	100 (5)	60 (3)	60 (3)	100 (5)
1010	TRUSSUM POND	100 (5)	80 (4)	80 (4)	100 (5)	80 (4)	80 (4)

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR DELAWARE 10/20/75

LAKE CODE 1009 WILLIAMS POND

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 23.10

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1009A1	23.10	68.00	78.00	92.00	73.00	54.00	42.00	32.00	50.00	30.00	35.00	43.00	54.00	54.13
1009A2	15.29	52.00	59.00	71.00	56.00	41.00	32.00	24.00	38.00	23.00	26.00	32.00	41.00	41.16
1009B1	4.01	14.00	16.00	19.00	15.00	11.00	8.70	6.50	10.00	6.20	7.20	8.90	11.00	11.10
1009C1	2.03	0.40	0.40	0.50	0.40	0.30	0.20	0.20	0.30	0.20	0.20	0.20	0.30	0.31
1009ZZ	1.77	1.60	2.60	1.40	1.60	1.70	1.10	1.30	1.70	0.60	1.60	1.90	1.70	1.56

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 23.10
SUM OF SUB-DRAINAGE AREAS = 23.10

TOTAL FLOW IN = 651.00
TOTAL FLOW OUT = 651.00

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1009A1	4	73	80.00	28	101.00				
	5	73	59.00	20	45.00				
	6	73	36.00	23	48.00				
	7	73	28.50	22	52.00				
	8	73	73.00	18	27.00				
	9	73	45.00	23	41.00				
	10	73	34.00	28	25.00				
	11	73	28.00	10	36.00				
	12	73	69.00	1	23.00				
	1	74	85.00	5	188.00				
	2	74	65.00	5	56.00	23	72.00		
	3	74	63.00	9	43.00	25	59.00		
1009A2	4	73	62.00	28	78.00				
	5	73	44.00	20	35.00				
	6	73	28.00	23	36.00				
	7	73	22.00	22	40.00				
	8	73	56.00	18	21.00				
	9	73	35.00	23	31.00				
	10	73	26.00	28	19.00				
	11	73	22.00	10	28.00				
	12	73	53.00	1	17.00				
	1	74	65.00	5	144.00				
	2	74	50.00	5	43.00	23	55.00		
	3	74	48.00	9	32.00	25	44.00		

TRIBUTARY FLOW INFORMATION FOR DELAWARE 10/20/75

LAKE CODE 1009 WILLIAMS POND

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1009B1	4	73	16.00	28	21.00				
	5	73	12.00	20	9.40				
	6	73	7.40	23	9.80				
	7	73	5.80	22	11.00				
	8	73	15.00	18	5.50				
	9	73	9.40	23	8.40				
	10	73	7.10	28	5.10				
	11	73	5.80	10	7.50				
	12	73	14.00	1	4.80				
	1	74	18.30	5	34.00				
	2	74	13.00	5	12.00	23	15.00		
	3	74	13.00	9	8.90	25	12.00		
1009C1	4	73	0.0	28	0.60				
	5	73	0.0	20	0.20				
	6	73	0.0	23	0.20				
	7	73	0.0	22	0.30				
	8	73	0.0	18	0.10				
	9	73	0.20	23	0.20				
	10	73	0.20	28	0.10				
	11	73	0.10	10	0.20				
	12	73	0.40	1	0.10				
	1	74	0.50	5	1.10				
	2	74	0.40	5	0.30	23	0.40		
	3	74	0.30	9	0.20	25	0.30		
1009Z2	4	73	1.60	28	1.40				
	5	73	2.70	20	0.40				
	6	73	0.40	23	2.00				
	7	73	0.60	22	0.80				
	8	73	1.60	18	0.40				
	9	73	0.40	23	1.40				
	10	73	0.70	28	0.80				
	11	73	0.10	10	0.30				
	12	73	1.60	1	1.10				
	1	74	1.50	5	3.90				
	2	74	1.60	5	0.70	23	1.60		
	3	74	1.70	9	1.90	25	2.70		

APPENDIX D

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 75/10/16

100901
38 38 38.0 075 36 17.0
WILLIAMS POND
10 DELAWARE

11EPALES
3

2111202
0008 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/10	15 05	0000	14.2		40	102	8.50	15	0.040	0.700	2.500	0.008
	15 05	0006	14.1	10.1		101	8.50	12	0.040	0.600	2.600	0.008
73/07/20	14 35	0000	28.3		42	112	8.50	25	0.050	1.100	0.100	0.010
	14 35	0004	27.2	6.2		111	7.30	24	0.090	1.10	0.080	0.012
73/09/28	14 45	0000	22.0	10.0	72	86	7.70	18	0.060	0.800	1.950	0.014
	14 45	0005	21.0			87						

24.

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/10	15 05	0000	0.037	13.5
	15 05	0006	0.034	
73/07/20	14 35	0000	0.086	61.1
	14 35	0004	0.093	
73/09/28	14 45	0000	0.042	20.9

STORET RETRIEVAL DATE 75/10/16

100902
38 39 03.0 075 35 36.0
WILLIAMS POND
10 DELAWARE

11EPALES
3

2111202
0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/10	15 20 0000		13.8		42	98	8.50	12	0.060	0.600	2.200	0.011
	15 20 0004		13.8	10.0		98	8.10	12	0.050	0.700	2.200	0.008
73/07/20	14 50 0000		28.6	12.1	36	108	9.50	22	0.040	1.100	0.060	0.010
73/09/28	15 00 0000		22.2	8.6	72	88	7.70	19	0.040	0.800	1.700	0.012

.95

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/10	15 20 0000		0.038	7.4
	15 20 0004		0.037	
73/07/20	14 50 0000		0.100	54.9
73/09/28	15 00 0000		0.044	22.8

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 75/10/16

1009A2
38 41 00.0 075 35 30.0
CLEAR BROOK
10 7.5 SEAFORD EAST
I/WILLIAMS POND
ST HWY 13A BRDG 2 MI N OF SEAFORD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/04/28	10 30		2.100	0.350	0.036	0.010	0.040
73/05/20	09 12		1.450	1.050	0.078	0.012	0.037
73/06/23	08 30		0.410	0.980	0.065	0.019	0.070
73/07/22	08 15		0.160	1.300	0.273	0.010	0.070
73/08/18	09 30			0.940	0.120	0.017	0.085
73/09/23	12 50		2.040	0.920	0.067	0.010	0.064
73/10/28	09 30		1.900	1.850	0.095	0.007	0.030
73/11/10	09 50		1.700	0.400	0.080	0.013	0.020
73/12/01	09 25		1.920	0.300	0.056	0.012	0.040
74/01/05	09 45		3.400	0.500	0.076	0.036	0.070
74/02/05			4.100	0.100K	0.055	0.007	0.013
74/03/09	13 00		3.080	0.700	0.030	0.010	0.030
74/03/25	10 30		2.900	0.600	0.035	0.015	0.060

27.

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/10/16

100981
38 39 30.0 075 36 00.0
HERRING RUN
10 7.5 SEAFORD EAST
T/WILLIAMS POND
ST HWY 13A BRDG 0.75 MI N OF SEAFORD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/04/28	11 10		4.600	0.280	0.070	0.015	0.030
73/05/20	09 07		4.650	0.660	0.095	0.012	0.025
73/06/23	09 00		3.800	0.130	0.070	0.023	0.030
73/07/22	08 35		3.800	1.050	0.072	0.026	0.115
73/08/18	10 05			0.500	0.048	0.021	0.040
73/09/23	13 20		4.900	0.335	0.050	0.017	0.025
73/10/28	09 45		4.700	0.100K	0.054	0.026	0.035
73/11/10	09 30		4.400	0.850	0.060	0.013	0.045
73/12/01	09 15		4.200	0.100K	0.034	0.012	0.015
74/01/05	09 40		5.500	0.200	0.044	0.012	0.015
74/02/05			5.700	0.200	0.025	0.005	0.007
74/03/09	12 45		5.200	0.400	0.025	0.010	0.050
74/03/25	11 30		5.500	0.500	0.050	0.010	0.025

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/10/16

1009C1
38 40 30.0 075 34 30.0
WILLIAM H NEWTON DITCH
10 7.5 SEAFORD EAST
T/WILLIAMS POND
HRDG 1 MI W OF MIDDLEFORD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/04/28	10 45		0.770	1.050	0.240	0.027	0.065
73/05/20	09 20		0.575	1.260	0.360	0.046	0.120
73/08/18	09 40			0.640	0.056	0.027	0.070
73/09/23	13 00		0.086	2.200	0.240	0.054	0.115
73/12/01	09 30		0.068	0.810	0.040	0.068	0.240
74/01/05	09 50		1.000	0.400	0.036	0.020	0.040
74/02/05			1.200	0.400	0.015	0.015	0.015
74/03/09	13 30		0.020	0.700	0.015	0.010	0.060
74/03/25	11 00		0.116	0.400	0.030	0.005	0.020